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SERMONS IN STOMACH STONES.

MOLIÈRE presents to us in one of his comedies the father of a dumb girl who wants to know why his daughter is dumb. 'Nothing is more easy to explain,' says the pretended physician Sganarelle; 'it comes from her having lost the power of speech.' 'Yes, yes,' objects the father, 'but the cause, if you please, why she has lost the power of speech?' Sganarelle is at no loss for an answer: 'All our best authors will tell you that it is the impeding action of the tongue.'

Somewhat similarly, if one asks the definition of a 'stomach stone,' one is told that it is a 'gastrolith';¹ and our best authors declare sapiently that gastroliths are pebbles that have been swallowed by fossil reptiles of '*lithophagous proclivities*'.² Predilection for this hard fare is accounted for by ascribing to the reptiles in question a bird-like gizzard; and the upshot of the matter is that we find evidence 'of additional important structural analogies with the birds,' *quod erat inveniendum*. Much the same method of reasoning led the jovial Tom Hood, in his 'Geological Excursion to Tilgate Forest, A.D. 2000,' to affirm that *Mylodon* subsisted upon a diet of 'raw potatoes and undressed salads.'

We have no wish to impugn the worth of stomach stones, nor of related bodies known as uroliths and coprolites, as a fit subject for scientific inquiry, and as a means of satisfying hunger and thirst after knowledge. All are capable of large returns, as witness, for example, the fecund results of M. Bertrand, whose memoir³ of 150 odd pages, illustrated by fifteen plates, is at once edifying, delectable and *digne*; that is, fully commensurate with the materials. The argumentation employed is informed with severest logic, in which undisciplined imagination has no place; and the author seeks to test, verify, or at least fortify, his conclusions as far as possible by the experimental method. An evident longing to get at the bottom of things is shown in

¹ SCIENCE, Vol. XXIII., p. 820.

² *Ibid.*, Vol. XX., p. 565.

³ 'Les coprolithes de Bernissart.' *Mém. Musée Roy. d'Hist. Nat. Belg.*, T. I., 1903.

the sections entitled by him 'Etude de la pâte fécale,' and 'Résumé de quelques expériences sur la destruction de divers types de crottins,' the latter including a notable category. Our foreign colleague is conspicuous for his firm grasp of the subject-matter, and his ornate handling of it sets an example which might well be emulated by his brethren on this side of the water. But then, as Seneca observes, speaking with all due respect: '*Gallum in suo sterquilinio plurimum posse.*'

C. R. EASTMAN.

SPECIAL ARTICLES.

THE FUTURE OF THE CRAYFISH INDUSTRY.

CRAYFISH in the United States form so small a part of the food supply that we are apt to rank them with mussels and snails as eaten in Europe only. But while France so highly appreciates them as to carry on the business of rearing them to increase the natural supply coming from her own waters and those of neighboring countries; there is actually a growing consumption of crayfish as food in the United States. In New York, New Orleans, San Francisco, Chicago and other cities crayfish are sold both as food and as garnish, as bait and as material for school and college courses in zoology.

While the actual status of the crayfish industry is difficult to determine, the following facts show that if a complete census were taken it would show the existence of a much larger use of crayfish than is at all suspected. One small region, the Potomac from Washington to Fort Washington, was recently estimated by one of the most intelligent fishermen on the Maryland side to send annually to New York a half million of crayfish, while the U. S. Fish Commission publications in 1884 asserted that Montreal and Milwaukee also shipped crayfish to New York. More recent reports of the commission state that in 1902 the crayfish catch in New Orleans County, Louisiana, was 16,000 pounds, of a value of \$615, and of Monroe County, Florida, 55,664 pounds, of a value of \$3,282.

All the above crayfish and many more caught for the markets of Chicago and other

central cities belong to the American genus *Cambarus*, which occurs in the United States and Canada only. The Potomac supplies *C. affinis*; Chicago, *C. virilis*; New Orleans, *C. Blandingii*; and Montreal, *C. Bartoni*. Of late, however, a considerable fishery has developed in the Pacific states where the crayfish are all of the genus *Astacus* and more like the crayfish of England, France and Europe in general. From the statistics of the Bureau of Fisheries we learn that in Oregon 116,400 pounds of crayfish, worth \$7,760, were caught in 1899. The detailed tables, however, assign 63,000 pounds, worth \$420, to Clackamas County, where they are taken in the tributaries of the Willamette River along a stretch of only a few miles; 5,400 pounds, worth \$360, to Columbia County; 15,000 pounds, worth \$1,000, to Multnomah County; 15,000 pounds, worth \$1,000, to Washington County; and 18,000 pounds, worth \$1,200, to Yamhill County. This would make a total of 165,000 pounds in place of 116,400 pounds.

The center of the wholesale crayfish business was Portland, in Multnomah County, where the sales were 39,232 dozen crayfish, weighing 117,696 pounds and worth \$19,556.¹

The catch is made in the sloughs of the Columbia and its tributary streams between March and September. A large part of the catch is used at Portland, with a considerable demand from Seattle, Tacoma, San Francisco and as far east as Salt Lake City and St. Louis. The average weight is three pounds to the dozen. As prepared for shipment the crawfish is placed alive in a composition of white wine and spices and boiled for about ten minutes. The crawfish and liquor in which it has been boiled are next packed in tin buckets holding from two to three dozen each.

Despite the incompleteness of the above data it is evident that considerable numbers of crayfish are sold and that they find a market even in Pacific, Atlantic and Gulf states, where they compete with salt-water crustacea; in San Francisco with the spiny-lobster and crab, in New Orleans with the shrimp and in New York with the lobster.

¹ "Notes on Fisheries of the Pacific Coast in 1899," p. 545.

The future of this crayfish industry will obviously depend upon both demand and supply. The demand should increase; with the growth of cosmopolitan populations that appreciate such food as is used in Europe; with the growth of large populations too remote from sea coast to obtain fresh sea food; and with the increasing inadequacy of the marine crustacea to supply the needs of even those consumers who dwell near the coast. Thus the lobster industry has been strained till the use of young specimens as food to take the place of the exterminated large ones has become very extensive. At present some millions of 'short-lobsters,' six to ten inches long, are sold to summer visitors to the New England coast and many more millions are used as bait.

No doubt, in time, the demand for crayfish will exceed the natural supply and this industry will tend to run the same retrograde course as that of the lobster, oyster, clam and many more important fisheries till the real, or assumed, value of the crayfish as food, warrants legislative control and scientific aid such as alone makes possible the continuance of more and more of our once 'inexhaustible' food supplies.

Soon or later the supply of crayfish will need to be made greater. In addition to legislative restrictions and controls three lines of work suggest themselves as suitable for trial when the supply becomes deficient or, if one is to profit by experience in other fisheries, now, before the supply is deficient. First the artificial breeding of native species in the market region; second, the introduction and propagation of better species than those naturally occurring; and thirdly, the improvement in size and flavor by culture and cross-breeding.

Crayfish amongst crustacea, like carp amongst fish, lend themselves readily to pond culture and breeding. Experiments carried on here in the laboratory have demonstrated the ease with which the young of *C. affinis* can be reared and have shown two facts of economic value, namely, that the young reared from eggs laid in the spring may become sexually

mature and lay eggs the following spring when not quite one year old, and also that a female may lay eggs in two successive years. As each lays from two hundred to six hundred eggs, a few breeding females would furnish a large stock of young. These young respond readily to feeding and the resulting size seems as much dependent upon the food as upon the age of the individual. Large individuals and large races might be expected from proper culture.

Though the eggs are best cared for by the mother, it was found possible to hatch them in McDonald fish-hatching jars and thus rear them under artificial conditions from a very early stage.

As each male is capable of fertilizing several females and, moreover, as it was found that in *Cambarus* the sperm may be kept all winter in the receptacle of the female and used by her to fertilize the eggs in the spring, few males are needed for breeding and these could be used as food in the winter before the spring, when so many of them die.

This kind of crayfish grew in the laboratory to a length of four inches in three and a quarter years and was of marketable size, three inches, at the end of the second summer from the egg. Probably in the open it attains its maximum size in four or five years.

A second method of improving the supply of crayfish, the introduction of other species, seems a promising field for experiment, for it has been found here that the eggs of the large Oregon crayfish, *Astacus*, may be hatched in the laboratory and reared as readily as in the case of *C. affinis*, the native species. These young Oregon crayfish grew here under such artificial conditions to a length of 60 mm. in five months from eggs hatched in the spring. This large species has been sold for twice the price of the eastern or the southern crayfishes, and besides its larger size and weight it has the advantage of more attractive and lobster-like appearance, so that its introduction into the east should be most acceptable. In fact, large specimens brought here and kept alive in the laboratory were as long as the six-inch 'short-lobster' now used as food, and if these

crayfish were available in quantity they might be used as a substitute for such young lobsters and thus protect the lobster industry.

As the scientific study of the geographical distribution of crayfish leads to the conclusion that the Oregon crayfish, *Astacus*, is absent from the whole eastern and central states because its ancestors never got there and not because of any natural obstacle to its living there when once introduced, it would seem well worth the while for the Bureau of Fisheries, and for private individuals, to introduce large numbers of young and adult *Astacus* into waters near markets not now supplied with this superior article of food. Should it be found that this large *Astacus* may be acclimated in the east to compete with *Cambarus*, say in the Potomac, or better to take the vacant places not now occupied by any crayfish at all (such as the Connecticut River) the catching of such introduced forms would be a lucrative business that would add an acceptable article to the food drawn from fresh waters. Even the artificial rearing of these larger crayfish in central and eastern waters awaits but the developments of time to be a profitable side of fresh-water farming.

A third means of increasing the available food supply—the origination of larger races of crayfish—may remain for a later stage of the industry, but as we have more than sixty species of *Cambarus* besides several species of *Astacus* in this country and nine or more other genera in other countries, the chances would seem good for some future production of new forms from crossing and selection.

In France as far back as 1865 a successful crayfish farm supplied Leon Soubeiran with the data for making out the life history of *Astacus*, and as we have found the habits of *Cambarus* here so similar there seems no obstacle to the establishment of crayfish farms in the United States except the lack of a sufficient demand for crayfish as food.

The needs of both *Astacus* and *Cambarus* have been shown in this laboratory to be simply air, a small amount of fresh water and organic food which may be a variety of refuse animal and vegetable matter. The artificial

culture of crayfish will be profitable as soon as the market price is greater than the small cost of food, the inexpensive farm and the value of the little labor involved. The introduction of the large Oregon crayfish with its attractive colors and large claws might conceivably so stimulate the general demand as soon to raise the market value to such a profitable level.

E. A. ANDREWS.

BALTIMORE, May, 1906.

TWO LETTERS OF DR. DARWIN: THE EARLY DATE OF HIS EVOLUTIONAL WRITINGS.

SEVERAL letters of Erasmus Darwin have lately come into my possession, and two of them seem worthy of publication, if only for the reason that reference to his evolutional ideas seldom occur in his correspondence. In this regard, for example, Charles Darwin states in his introduction to Dr. Krause's 'Erasmus Darwin,' that 'most of the letters [of his grandfather] which he possessed or had seen, are uninteresting and not worth publication.'

The earlier letter, I may note, has the merit of referring to Dr. Darwin's work on the anatomy of plants, and to his ingenious effort to show closer correspondence between the organs of the higher plants and the higher animals. Indeed, as we know from other sources, he even expected ultimately to find in plants the homologues of the animal nerves, ganglia and sense organs. Accordingly, we are not surprised to find that he refers here, in quite a matter of fact way, to the 'blood' and the 'two systems' of a plant. And he gives us also a glimpse of laboratory methods, and of his interest in getting in prompt touch with the results of foreign workers.

The first of these letters is addressed to 'Sir Joseph Banks, Bar^t' Soho Square London.' and is as follows:

RADBURN MAR. 16—82

Dear Sir,

I return'd your sixth volum of the Ameenit. academ. & thank you for the loan of it. I should have sooner sent it, but hoped to have received another copy of Murray, & also that Dr. Linneus's supplementum would have been procured from

abroad, & thence meant to have returned them together.

Mrs. Blackburn favor'd us with a copy of Murray, but desired it to be returned in three months, which it was to a day; & as I could procure but one other, & our society was not all resident at Lichfield, we were distressed on this account, but are still flatter'd with daily hopes of more copies being imported. I am sorry you say the remainder of the supplementum is not likely soon to be had.

On looking over Malpighi, & Grew, & Hales, the physiology of plants appear'd to me, not to have hitherto been under the attention of any one perfectly acquainted with the animal economy. Last summer I contrived to inject the absorbent system of the Picris with a colour'd liquor; & as the blood of that plant is white, these two systems were beautifully apparent to the eye. On reading a manuscript translation of Mr. —— a Sweedish naturalist, I found the authors, I mentioned to you in my last, had made a set of similar experiments; & I had designed to have investigated this subject, so little understood at present, farther during the summer.

This however I have now laid aside, for perhaps more important, tho' less ingenious occupations; & shall therefore decline giving you the trouble of sending me the books you are so kind as to offer, both in your last, & in a former letter of yours, I am S^r.

with great respect

your obed^t. servt^t.

E. DARWIN.

The second letter is of livelier interest. He denies having 'stolen' his 'Botanic Garden,' or of even having heard of its prototype, probably the 'Universal Beauty' of Brooke (1735). And he modestly predicts of the effect of his evolutional 'conjectures.' Finally, he refers to the 'Zoonomia,' as having been on his work table—or rather 'lain by him' for 'nearly twenty years'—i. e., since about 1771. That the work here referred to is the 'Zoonomia,' there can be no doubt; he obviously means an extended evolutional work, and, in a letter to a son, dated the following year (cited in the introduction to 'Erasmus Darwin,' above referred to, page 102), he says, that "he is studying his 'Zoonomia.'" It is, of course, well known that this work was long intended for posthumous publication. But the exact